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THE MICROSCOPE IN THE WORKSHOP.

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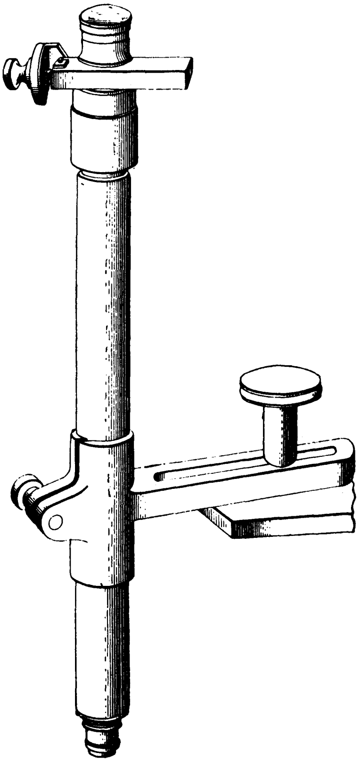
The writer has on several occasions called attention to the advantages to be derived from the use of the microscope in the ordinary operations of mechanical construction. A somewhat extended experience has not only established the feasibility of its use as a workshop tool, but has given a practical demonstration of the fact that it may be made the means of reducing the cost of construction and of increasing uniformity on all measured dimensions.

There are two objections which at once present themselves to the mind of the manager of a machine shop when it is proposed to use the microscope as a machine tool, which at first sight seem insurmountable.

It is the common impression that a special and expensive machine would be required for its use, and that a foundation separate from the building would be necessary in order that there may be no disturbance of vision by the running of machinery, heavy hammering, &c. A second objection is likely to be urged, viz., that it would be impossible to secure an adequate illumination of metal surfaces in the measurement of dimensions without special appliances, the manipulation of which would require a degree of skill hardly to be expected, even in an exceptionally intelligent workman.

In any plea for a more extended use of the microscope in ordinary workshop practice, let it be granted at the outset that the practical mechanic may properly require that its claim to recognition shall rest upon the conditions which ordinarily exist in a workshop. Can the microscope, under these conditions, be made a useful tool in connection with the lathe, the planer, the milling machine, the gear-cutter, &c.?

The writer contends that even under these conditions the two objections mentioned are not valid. With regard to the first one, it is only required that the microscope tube, the holder, the objective, and the eye-piece shall be firmly connected, and that the holder shall be securely clamped to any machine in connection with which it is to be used. The degree of rigidity required cannot be secured in the form of mounting employed in the ordinary construction of the microscope. The form shown in the accompanying figure has been found to be well adapted to its purpose. The walls of the tube, which may be made either of brass or of iron, are one-eighth of an inch in thickness.



A holder of this form clamped to the tool post of a lathe will enable the workman to use a power of from 100 to 200 without much difficulty. Clamped to the tool post of a heavy planer, the images formed by the objective will be found to be surprisingly steady. Even when there is a slight tremor, due to the running of machinery, there will be no real disturbance of position and no serious interference with steadiness of vision. This fact was strikingly illustrated in a test made by the writer, of a long screw, in the shop of R. Hoe & Co. The room in which the investigation was made contained greater elements of disturbance than would ordinarily occur, and yet such was the stability of the mounting of the lathe that the measurements were made with the greatest ease and precision. In a shop comparator weighing about 1,500 pounds, mounted over one of the main beams in the middle of the machine shop of this firm, the images in the microscope are remarkably steady.

The second objection urged is met in the most satisfactory manner by the use of the prism illuminator, invented by the late R. B. Tolles. This prism is mounted permanently just back of the front lens of the objective. The light strikes a plane face, passes to a face making with it an angle of 45 degrees, where it is totally reflected and passes out nearly parallel with the axis of the lens. The amount of light cut off from the objective by the prism is not sufficient to be observed.

It is the great advantage of this form of illumination that it is only necessary that the plane face of the prism shall be directed toward the sky through any window, however distant, in order to get a superb illumination of a metal surface, even when its brightness is no greater than would result from ordinary turning and planing.

The limitations of space forbid a complete description of the operations in which the microscope may be advantageously employed. It will be sufficient to enumerate a few of the problems in which the writer has made use of the microscope as a working tool:

(1.) To level the bed of a planer by a reference to the surface of clean mercury, supported independently of the platen. The microscope is attached to the platen and passes over the surface of the mercury by the movement of the platen. The objective can be sharply focused upon the surface of the mercury within from .001 inch to .0005 inch, according to the power employed. Granules of lycopodium powder, scattered loosely upon the surface of water, answer equally well if the water can be made to remain in a quiescent state. Good results have been obtained by the use of a block of hard wood covered with shellac, having a brass plug inserted at the center upon which reference lines were drawn.

(2.) To determine whether the surface of a platen is a plane surface at every point.

(3.) To determine whether the movement of the carriage on the cross-head of a planer is parallel with the platen.

(4.) To determine whether a surface which has been planed is a true surface before it is taken off the planer.

(5.) To determine whether an edge which has been planed is a straight edge before the work is taken off the planer.

(6.) To determine whether two planed surfaces which are not in the same plane are parallel before the work is taken from the planer.

(7.) To determine whether a surface is constrained before it is planed.

(8.) To eliminate the flexure of a planed surface.

(9.) To determine whether the ways of a planer have local irregularities.

(10.) To determine whether the line between the centers of a lathe is parallel with the movement of the carriage.

(11.) To determine whether a surface which has been turned is truly round.

(12.) To set the tail-stock so that the diameters of a turned piece shall be the same at every point.

(13.) To determine the flexure of a piece of metal which has been turned while it is on the centers.

(14.) To determine whether the screw of a lathe has the same pitch at every point and at every part of a revolution.

(15.) To graduate the index wheel of a screw-lathe—*e. g.*, into 1,000 equal parts—and secure freedom from cumulative errors.

(16.) To set a turned shaft upon the centers so that its axis shall be parallel with the ways of a lathe.

(17.) To determine the horizontal curvature of a surface by the measurement of chords on opposite sides of the axis of motion.

(18.) To reduce the surface thus investigated to a plane surface.

(19.) To determine the vertical curvature of a surface by the measurement of chords in a vertical plane at different heights from the surface.

(20.) To reduce the surface to a plane surface.

(21.) To determine whether the carriage of a lathe describes a straight line by means of a wire stretched taut and set parallel with the ways.

(22.) To cut a gear having any required number of teeth upon a screw-lathe with the aid of an index wheel subdivided into 1,000 equal parts.

(23.) To reduce the surface of a bar of metal to a plane surface when it is supported at two given fixed points.

(24.) To determine with two microscopes the law of yielding in a bar of metal when subjected to stress in the Emery testing machine.